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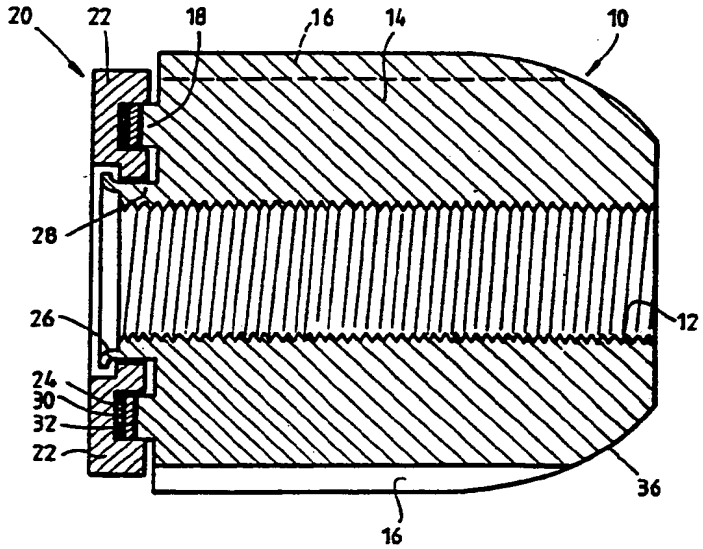
(54) Title: TOOTHED FASTENER

(57) Abstract

A toothed fastener (10) having a threaded portion (12), and a head portion (14) provided integral to the threaded portion (12), the head portion (14) having a toothed outer periphery (16) and a pressure transmitting surface (18). The fastener also has a friction reducing means (20) comprising a first part (22) having a first pressure transmitting surface (24) and a second part (32) having second and third pressure transmitting surfaces. The second part (32) is located between the head portion (14) of the fastener (10) and the first part (22). A solid dry lubricant material (30) in the form of an annulus is located between the first and second parts (22, 32) to reduce friction therebetween, whereby the first part (22) can be held stationary relative to the object to be fastened so that the dry lubricant material (30) acts as a bearing between the head portion (14) of the fastener and the fastened object when the fastener (10) is tightened or loosened by engaging the toothed outer periphery (16). A fastening tool (46) having a toothed portion (52) for tightening and loosening the toothed fastener, together with a modified automotive wheel (40) incorporating toothed wheel fasteners (42) is also disclosed. The toothed wheel fastener (10, 42) facilitates more efficient fastening and removal of a wheel as well as improved security against theft.



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TOOTHED FASTENER

FIELD OF THE INVENTION

The present invention relates to a toothed fastener having a head portion with a toothed outer periphery and friction reducing means for substantially reducing the frictional resistance normally encountered during tightening or loosening of a fastener. The invention relates particularly, though not exclusively, to a toothed automotive wheel fastener of this kind.

BACKGROUND TO THE INVENTION

A conventional wheel nut or bolt comprises a head portion designed to receive a wheel brace or spanner, a threaded portion to screw onto the inner flange of the brake drum located on the wheel axle and a tapered cone portion shaped to engage in a matching shaped recess provided in the wheel. In some arrangements the cone portion is provided separate from the head portion and sometimes the fastener is further provided with a conventional washer behind the cone. In other arrangements, particularly on truck wheels the wheel nuts or bolts have a flat surface rather than a cone portion.

Irrespective of the form of the wheel fastener a primary objective during tightening is to pre-load the bolt or wheel stud so as to improve both fatigue resistance and the locking effect. When a conventional wheel fastener is tightened a high degree of friction is encountered, comprising, friction on the threaded portion, friction on the conical wheel recess and friction on the cone or flat portion contacting the wheel surface or recess. Thus it is necessary to apply significantly more torque than would theoretically be needed to a conventional wheel nut or bolt during fastening in order to overcome the frictional resistance and still obtain the necessary hold-down or clamping pressure. This becomes very significant on heavy vehicles where the torque required to overcome friction and attain clamping pressure is typically

very high. Fastener friction therefore causes expenditure of wasteful energy both during tightening and loosening. Furthermore, fastener friction also causes inaccurate reading of the torque tension of the fastener. In practise it is extremely difficult to distinguish the torque required to overcome friction from the torque required to attain the necessary clamping pressure and this can lead to the wheel not being securely clamped to the wheel flange.

Conventional fasteners have evolved with a means to grip the fastener with a fastening tool, (spanner or wrench), in the form of either a six sided head or in some instances a twelve sided head. The high torque required to tighten high tension load fasteners has dictated this head shape as the flats and corners are able to take the load applied by the tool as well as provide a sure grip for the tool. Where reduced torque loadings are all that is required to tighten or loosen the fastener the head shape required to grip and turn the fastener can be different from the conventional six or twelve sided head. This leads to the possibility of also reducing the size and altering the nature of the fastening tool.

A further problem with conventional wheel fasteners is that the flats on the head of the fastener must be accessible to allow tightening and loosening of the fastener by engaging the flats with a fastening tool such as a spanner, wrench or wheel brace. A wheel brace or ring spanner is typically provided with a socket adapted to be received over the head of the fastener so as to engage the flats on all sides. Alternatively the fastening tool may be an open-ended spanner adapted to engage the flats on the head of the fastener on two or three sides. These traditional means to grip a fastener with a fastener tool also dictate how access is obtained to turn the fastener.

Modern alloy wheels are typically provided with recessed apertures adapted to receive the wheel fasteners therein, but unavoidably such recesses must also be large enough to receive the socket of the fastening tool. Thus the wheel fasteners remain exposed and accessible to unauthorised removal and theft. Various attempts have been made to overcome

this problem including a lockable wheel nut, and a lockable wheel hub that covers the wheel fasteners. These solutions have had limited success in deterring thieves.

The present invention was developed with a view to providing a fastener which is capable of improving on or overcoming one or more of the above-noted problems with conventional threaded fasteners. Although the invention will be described with particular reference to automotive wheel fasteners, it is to be understood that the fastener is not limited to automotive fasteners and can be used in any application to improve security and/or to enable rapid tightening or loosening of a fastener with less torque.

SUMMARY OF THE INVENTION

According to one aspect of the present invention there is provided a toothed fastener comprising:

a threaded portion;

a head portion provided integral to the threaded portion and having a toothed outer periphery and a pressure transmitting surface; and,

a friction reducing means comprising:

a first part having a first pressure transmitting surface adapted to rotatably receive said pressure transmitting surface of the head portion in facing relation thereto; and,

a solid dry lubricant material provided to reduce friction between said head portion and the first part of the friction reducing means

whereby, in use, said first part can be held stationary relative to the fastened object so that said dry lubricant material can act as a bearing for the head portion of the fastener when said fastener is tightened or loosened by engaging said toothed outer periphery.

Typically said solid dry lubricant material is in the form of a separate annulus located between said first pressure transmitting surface and the pressure transmitting surface of the head portion.

Preferably said first part is in the form of an

annular member having an annular recess provided therein within which said solid dry lubricant annulus is contained. Advantageously, said pressure transmitting surface of the head portion of the fastener is formed on an annular protrusion, said annular protrusion having an outside diameter slightly smaller than the inside diameter of the annular recess provided in the annular member. The head portion of the fastener may be coated with a film of anti-friction material having a low coefficient of friction.

In one embodiment said head portion of the fastener has an outer circumferential surface of substantially cylindrical shape having a plurality of gear teeth extending over substantially the whole of said cylindrical surface. In another embodiment said outer circumferential surface has a plurality of gear teeth extending over a portion only of said cylindrical surface, the remainder of said cylindrical surface having a plurality of flats arranged as in a conventional fastener.

According to another aspect of the present invention there is provided a wheel having a plurality of apertures provided therein each adapted to receive a wheel fastener having a toothed head portion, the wheel comprising:

a recess adapted to rotatably receive a fastening tool inserted therein whereby, in use, a fastener received in one of said apertures can be tightened or loosened by inserting said fastening tool into said recess and rotating the tool with the teeth of a toothed portion of the tool mechanically coupled to the teeth on the head portion of the fastener.

In one embodiment said recess is one of several recesses each provided adjacent a respective aperture for the wheel fasteners.

Advantageously, each of said apertures for the fasteners is recessed to rotatably receive the head portion of the fastener in a close fit therein whereby, in use, the fastener head portion can only be engaged laterally by means of the fastening tool through an adjacent recess. The fastener can also be locked by leaving the tool engaged with the teeth of the fastener head portion and making the tool immobile in

the recess adjacent the aperture.

According to a still further aspect of the present invention there is provided a fastening tool for a fastener having a toothed head portion, the tool comprising:

a shank having means for gripping the tool; and,

a toothed portion provided on the shank, having teeth adapted to engage the teeth of the toothed head portion of the fastener whereby, in use, the toothed head portion of the tool can be mechanically coupled to the head portion of the fastener and rotated to loosen or tighten the fastener.

In one embodiment, said tool is in the form of a key having said gripping means at one end of the shank and said toothed portion proximate the other end of the shank.

Preferably, said shank is in the form of a shaft of circular cross-section. Advantageously, said toothed portion of the key has a diameter smaller than the diameter of the toothed head portion of the fastener.

A recess into which the shank of the tool is inserted may be provided adjacent the aperture in the object to be fastened or may be provided in a separate key support.

The key is particularly advantageous for use with a wheel fastener having a toothed head portion and incorporating friction reducing means as described above. In its application to a wheel fastener, the wheel may be provided with a recess adjacent each fastener hole, for receiving the shank of the key. The low torque required to tighten or loosen the fastener incorporating the friction reducing means that a small key can be used to loosen or tighten the fastener manually, and being small the tool is able to fit into space available adjacent the fastener. The toothed portion of the key being of smaller diameter provides a mechanical advantage as determined by the gear ratio.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to facilitate a better understanding of the nature of the invention, several embodiments will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a section view through one embodiment of a toothed fastener according to the invention;

Figure 2 is a plan view of the toothed fastener of Fig.1;

Figure 3 illustrates one embodiment of an automotive wheel incorporating toothed wheel fasteners;

Figures 4(a) (b), and (c) illustrate a fastening tool for tightening and loosening a toothed fastener; and,

Figures 5(a), (b) and (c) illustrate a variant of the arrangement shown in Figure 6.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Figures 1 and 2 illustrate a preferred embodiment of a toothed fastener 10 according to the invention in the form of a wheel nut. The wheel nut 10 comprises a threaded portion 12 for screw threaded engagement with a matching thread of a bolt or stud provided on the flange of the brake drum located on a vehicle axle (not illustrated) to which a wheel is fastened. The wheel nut 10 further comprises a head portion 14 provided integral to the threaded portion 12 and having a toothed outer periphery 16 and a pressure transmitting surface 18 formed on an annular protrusion provided coaxial with the threaded portion 12 of the wheel nut. The wheel nut also comprises a friction reducing means 20 comprising a first part 22 having a first pressure transmitting surface 24 adapted to rotatably receive the pressure transmitting surface 18 of the head portion 14 in facing relation thereto. In this embodiment the first part 22 is in the form of an annular member having an annular recess provided therein, the width of the annular recess being slightly larger than the width of the annular protrusion 18 provided on the head portion 14 of the wheel nut. Thus, the annular member 22 is free to rotate with respect to the wheel nut 10 with the annular protrusion 18 of the head portion 14 slidably received within the annular recess of the annular member. Advantageously, the head portion 14 of the wheel nut is provided with an annular lip 26 adjacent a necked portion 28 of the wheel nut on which the annular member 22 is rotatably supported. The annular lip 26 can be bent outwardly

as illustrated in Figure 1 to retain the annular member 22 on the wheel nut. If desired a washer of resilient material may be provided adjacent the lip 26 to bias the first part 22 towards the head portion 14 and to act as a seal against the ingress of dust and other contaminants.

The friction reducing means 20 further comprises a solid dry lubricant material 30 in the form of a separate annulus located between the first part 22 and the head portion 14 to reduce friction therebetween. The solid dry lubricant annulus 30 is contained within the annular recess of the first part 22 adjacent the first pressure transmitting surface 24. The annular recess contains the solid dry lubricant annulus and prevents cold flow of the lubricant material when subjected to high compressive load.

In this embodiment, the friction reducing means 20 further comprises a second part 32 located between the head portion 14 of the wheel nut and the first part 22 of the friction reducing means 20. As illustrated in Figure 1, the second part 32 is in the form of a washer rotatably received within the annular recess of the first part 22, and having second and third pressure transmitting surfaces adapted to receive the respective pressure transmitting surfaces of the first part 22 and the head portion 14 in facing relation thereto. Advantageously, the washer 32 is manufactured from a finely grained, non-corrosive material than the head portion 14 of the wheel nut, for example, stainless steel, and provides a smooth pressure transmitting surface for sliding engagement with the solid dry lubricant annulus 30. Hence, if the first part 22 is held stationary relative to the fastened object and the second part 32 rotates with the head portion 14 of the wheel nut 10, the solid lubricant annulus 30 acts as a bearing for the head portion of the wheel nut when the wheel nut is tightened or loosened by engaging the toothed outer periphery 16. The washer 32 also helps to contain the solid lubricant material within the annular recess of the first part 22, and is manufactured to be rotatably received within the annular recess to a close tolerance.

The head portion 14 of the wheel nut has an outer

circumferential surface of substantially cylindrical shape having a plurality of gear teeth 34 extending over substantially the whole of the cylindrical surface, as illustrated most clearly in Figure 2. As can be seen in Figure 1, one end of the wheel nut 10 is provided with a chamfer 36, as on a conventional wheel nut, to allow a socket of a fastening tool (not illustrated) to be fitted thereto more easily. However, the principal advantage of the toothed outer periphery 16 of the wheel nut 10 is that the wheel nut can be tightened or loosened by engaging the teeth 34 laterally with a fastening tool, rather than coaxially as with conventional wheel fasteners. An embodiment of an automotive wheel incorporating toothed wheel fasteners will now be described with reference to Figure 3.

Figure 3 illustrates a wheel 40, typically manufactured from magnesium/aluminium alloy material. The wheel 40 is fastened to a wheel flange of the brake/drum on the vehicle axle by means of five toothed fasteners in the form of wheel bolts 42 (see Figure 4). Each of the toothed wheel bolts 42 comprise a threaded portion, and a head portion provided integral to the threaded portion and having a toothed outer periphery and a pressure transmitting surface. Each wheel bolt 42 also comprises a friction reducing means (not visible) which is structurally and functionally similar to the friction reducing means 20 of the wheel nut 10 illustrated in Figures 1 and 2. The toothed outer periphery of the wheel bolts 42 is formed on an outer cylindrical surface of the head portion of the wheel bolts.

The wheel 40 is provided with five recessed apertures 44 within which each of the wheel bolts 42 can be received. Each of the recessed circular apertures 44 is dimensioned to rotatably receive the head portion of the wheel bolts 42 in a close fit therein. Hence, the teeth on the head portion of the wheel stud can only be engaged laterally for tightening and loosening, by means of a fastening tool 46 (see Figure 4).

The fastening tool 46 illustrated in Figure 4 comprises a shank 48 having means for gripping the tool in the form of a handle 50 at one end of the shank. The tool 46

further comprises a toothed portion 52 intermediate the length of the shank 48 having teeth adapted to engage the teeth of the toothed head portion of the wheel bolts 42. Each of the circular apertures 44 in the wheel 40 is provided with an adjacent aperture 54 within which the shank 48 of the fastening tool 46 can be rotatably received so that the teeth of the tool can engage with the teeth of the toothed head portion of the wheel bolt.

The provision of fastening tool 46 not only enables more efficient tightening and loosening of the wheel bolts 42, but also provides improved security against theft, since would-be-thieves must have a fastening tool with toothed head portion in order to remove the wheel bolts 42.

It is largely the provision of friction reducing means in each of the wheel bolts 42 that enables the torque required to tighten/loosen the wheel fasteners to be kept to a minimum. The friction reducing means significantly reduces the torque required to tighten the wheel fasteners while maintaining adequate clamping pressure. Indeed, the reduction in torque required to achieve the required clamping pressure facilitated by the provision of the friction reducing means in the wheel fasteners, enables the number of wheel fasteners required to fasten the wheel to the vehicle axle to be reduced. Thus, for example, the wheel may be designed to receive only three fasteners, rather than five as in the illustrated embodiment, and still be able to achieve the same hold-down pressure as five conventional wheel fasteners. This is particularly true on wheels where most of the vertical load is in fact carried by the wheel hub rather than the wheel fasteners.

Preferably, the number of teeth provided on the head portion of the toothed fastener is designed to be a maximum to provide additional mechanical advantage, and is limited only by the diameter of the head portion of the fastener and the need to keep the teeth large enough to withstand the load applied during tightening/loosening of the fastener.

The wheel 40 may be further provided with a security hub cap (not illustrated) which covers all of the apertures 44

and thus further inhibits unauthorised access to the wheel fasteners. The hub cap is provided with five projecting parts slidably received in the apertures 54 and adapted to engage the teeth of the head portions of the wheel bolts 42 and thus lock them in position. The hub cap can be locked on the wheel using a conventional key operated lock in known fashion.

Figure 4(a), (b) and (c), illustrate in greater detail the arrangement for enabling secure loosening and tightening of the toothed fastener 42 in the form of a wheel bolt incorporating friction reducing means similar to that illustrated in Figure 1. The friction reducing means of the wheel bolt 42 illustrated in Figure 4(a) is provided with a first part 56 having a frusto-conical surface 58 which is received in the cone-shaped aperture 44 provided in the wheel 40. In other respects, the friction reducing means is structurally and functionally equivalent to that of the fastener illustrated in Figure 1. The first part 56 is provided with an annular recess in which a solid dry lubricant annulus 60 is received, together with a second part 62 in the form of a stainless steel washer. In this embodiment the shank of the bolt coacts with the annular recess to contain the solid lubricant annulus 60.

The head portion of the fastener 42 is provided with gear teeth 45 on its outer periphery whereby, in use, the fastener can be tightened or loosened by inserting a fastening tool 46 into the recess 54 provided adjacent the head portion of the fastener 42 in the wheel 40, and rotating the tool 46 with the toothed portion 52 of the tool engaging the teeth 45 on the head portion of the fastener 42.

The particular embodiment of the fastening tool 46 illustrated is in the form of a key comprising a shank 48 in the form of a shaft of circular cross section, and having means for gripping the key in the form of a handle 50 at one end. The toothed portion 52 of the fastening key is provided with teeth on its outer periphery adapted to engage the teeth 45 of the head of the fastener 42. The recess 54 in the wheel 40 is provided with a shoulder on which the toothed portion 52 sits with the shaft 48 extending into the bore of the recess 54 and

being freely rotatable therein. As can be seen most clearly in Figure 5(c) the toothed portion 52 of the fastening tool 46 is of smaller diameter than the head of the fastener 42 and therefore a mechanical advantage is provided due to the difference in the number of gear teeth.

Obviously, the gripping means of the fastening tool 46 need not be in the form of a handle 50 as in the illustrated embodiment, but may be adapted to be received in the chuck of a power tool to enable rapid tightening or fastening of the toothed fastener 42. However, the principal advantage of this arrangement is that it enables manual tightening or fastening of the fastener 42 using a small fastening tool of the kind illustrated. This is possible due to the relatively low torque required to obtain the necessary hold-down or clamping pressure with the fastener 42 on the wheel, due to the provision of the friction reducing means in the fastener 42.

Figure 5(a), (b) and (c) illustrate a variant of the arrangement illustrated in Figure 4, which operates in a substantially identical manner, but does not require the provision of a recess adjacent the fastener aperture in the actual object to be fastened, for receiving the shank of the fastening tool. In this alternative arrangement, a key support 110 is provided having a first aperture 112 through which the threaded portion of the fastener 42 is received, and a second aperture 114 in which the end of the shank 48 of the fastening tool is rotatably received. The key support 110 is provided with an arcuate wall section 116 which acts as a guide for the fastening key 46 during rotation of the latter in the aperture 114. A guide ring 118 provided on the shank of the fastening key slidably engages the inner surface of the arcuate wall section 116 and enables the fastening key 46 to rotate freely with the toothed portion 52 engaging the teeth on the periphery of the head portion of the toothed fastener 42.

As can be seen clearly in Figure 5(a), the first part 120 of the friction reducing means is similar to the first part 22 of the first embodiment described above and illustrated in Figure 1. Furthermore the head portion of the fastener 42 is also provided with a pressure transmitting surface 122 as in

the embodiment of Figure 1. The fastening key 46 in this alternative arrangement functions in substantially identical manner to that in Figure 4.

Fasteners of the above kind could be used on motor vehicles, farm machinery, tractors, trucks and industrial machinery, and will be particularly advantageous where parts are regularly changed or replaced as the fasteners can be quickly removed and replaced. When used in conjunction with a fastening tool or key as described above, the toothed fastener can be easily tightened or loosened with as little as a single revolution of the key. The toothed head portion of increased diameter also provides a positive gripping surface for manual fastening or loosening. The head portion of the toothed fastener may also have a normal tool grip, for example, an internal hexagon recess, or may incorporate a manual gripping device of the kind disclosed in co-pending International Application No. PCT/AU91/00420, to facilitate manual tightening and loosening. Thus, for example, the fastener may be rapidly turned manually, and then tightened or loosened using a key or fastening tool as herein described.

The friction reducing means employed in the toothed fastener of the present invention substantially reduces the turning friction encountered during tightening and loosening of the fastener. Therefore the six or twelve sided head portion of a conventional fastener, dictated by the high torque required to overcome friction, can be replaced with a toothed head portion in the present invention, wherein only one or two teeth of the head portion need be engaged during tightening or loosening of the fastener. This would not be possible without the friction reducing means, unless the size of the head portion was significantly increased, since the load on one or two teeth would be too great. Furthermore, the reduced torque required to turn the fastener enables the use of a toothed fastening tool, preferably of lesser diameter, which engages at least one side of the toothed head portion. A mechanical advantage can be obtained by selecting an appropriate gear ratio between the teeth on the tool and on the fastener.

The solid dry lubricant material employed in the

friction reducing means in each of the above described embodiments may be any suitable material, for example, a fluoropolymer plastic having a low coefficient of friction such as PTFE, commonly known as Teflon. Advantageously, the PTFE may be combined with powdered glass in order to produce a dry lubricant material having a minimum coefficient of friction and capable of withstanding a large compressive force. The most preferred form of the solid dry lubricant material is Teflon or a composite incorporating Teflon. Teflon is particularly suitable because it is resilient, has a low coefficient of sliding friction and is wear resistant. Hence, when used in the friction reducing means of the invention it can act as a pressure absorbing element and may act to apply an axially directed pre-loading force to the fastener. This pre-loading provided by the Teflon may coact with the normal pre-loading obtained by tensioning the stud or bolt of the fastener. Teflon has other unique characteristics which make it particularly suitable for this application; it is inert, non-moisture absorbing and thermally stable.

It is not essential that the solid dry lubricant material be provided as a separate integer in the friction reducing means. It may, for example, be provided integral to said first part, the first part being itself made wholly or partly of said dry lubricant material or in the form of a composite. It is essential that the dry lubricant material act to reduce friction between the respective pressure transmitting surfaces of the head portion of the fastener and the first part of the friction reducing means.

It will be apparent to persons skilled in the mechanical arts that numerous variations and modifications may be made to the described embodiments of the toothed fastener, in addition to those already described, without departing from the basic inventive concepts. For example, the toothed outer periphery of the head portion need not have teeth provided over the entire periphery, and may have teeth over only a fraction of the circumference. Furthermore, the teeth need not extend over the whole of the periphery in an axial direction, but may extend over only a portion, the remainder being smooth or

having flats as on a conventional fastener. All such variations and modifications are to be considered within the scope of the present invention, the nature of which is to be determined from the foregoing description and the appended claims.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A toothed fastener comprising:

a threaded portion;

a head portion provided integral to the threaded portion and having a toothed outer periphery and a pressure transmitting surface; and,

a friction reducing means comprising:

a first part having a first pressure transmitting surface adapted to rotatably receive said pressure transmitting surface of the head portion in facing relation thereto; and,

a solid dry lubricant material provided to reduce friction between said head portion and the first part of the friction reducing means

whereby, in use, said first part can be held stationary relative to the fastened object so that said dry lubricant material can act as a bearing for the head portion of the fastener when said fastener is tightened or loosened by engaging said toothed outer periphery.

2. A toothed fastener as claimed in claim 1, wherein said solid dry lubricant material is in the form of a separate annulus located between said first pressure transmitting surface and said pressure transmitting surface of the head portion.

3. A toothed fastener as claimed in claim 2, wherein said solid dry lubricant material is a fluoropolymer plastic having a low coefficient of friction.

4. A toothed fastener as claimed in claim 2, wherein said first part is in the form of an annular member having an annular recess provided therein within which said solid dry lubricant annulus is contained.

5. A toothed fastener as claimed in claim 5, wherein said pressure transmitting surface of the head portion of the

fastener is formed on an annular protrusion, said annular protrusion having an outside diameter slightly smaller than the inside diameter of the annular recess provided in the annular member.

6. A toothed fastener as claimed in claim 1, wherein said friction reducing means further comprises a second part having second and third pressure transmitting surfaces, said second part being located between the head portion of the fastener and the first part of the friction reducing means, with said third pressure transmitting surface being adapted to receive said pressure transmitting surface of the head portion in facing relation thereto, and said second pressure transmitting surface being adapted to receive said first pressure transmitting surface in facing relation thereto.

7. A toothed fastener as claimed in claim 6, wherein said second part of the friction reducing means is in the form of a washer adapted to rotate with said head portion of the fastener.

8. A toothed fastener as claimed in claim 1, wherein said head portion of the fastener has an outer circumferential surface of substantially cylindrical shape having a plurality of gear teeth extending over substantially the whole of said cylindrical surface.

9. A wheel having a plurality of apertures provided therein each adapted to receive a wheel fastener having a toothed head portion, the wheel comprising:

a recess adapted to rotatably receive a fastening tool inserted therein whereby, in use, a fastener received in one of said apertures can be tightened or loosened by inserting said fastening tool into said recess and rotating the tool with the teeth of a toothed portion of the tool mechanically coupled to the teeth on the head portion of the fastener.

10. A wheel as claimed in claim 9, wherein each of said apertures for the fasteners is recessed to rotatably receive the head portion of the fastener in a close fit therein whereby, in use, the teeth on the fastener head portion can only be engaged laterally by means of the fastening tool through an adjacent recess.

11. A fastening tool for a fastener having a toothed head portion, the tool comprising:

a shank having means for gripping the tool; and,

a toothed portion provided on the shank, having teeth adapted to engage the teeth of the toothed head portion of the fastener whereby, in use, the toothed head portion of the tool can be mechanically coupled to the head portion of the fastener and rotated to loosen or tighten the fastener.

12. A fastening tool as claimed in claim 11, wherein said tool is in the form of a key having said gripping means at one end of the shank and said toothed portion proximate the other end of the shank.

13. A fastening tool as claimed in claim 12, further comprising a key support having an aperture in which an end of the shank of the tool is rotatably received for supporting the key during tightening or loosening with the threaded portion engaging the head portion of the fastener.

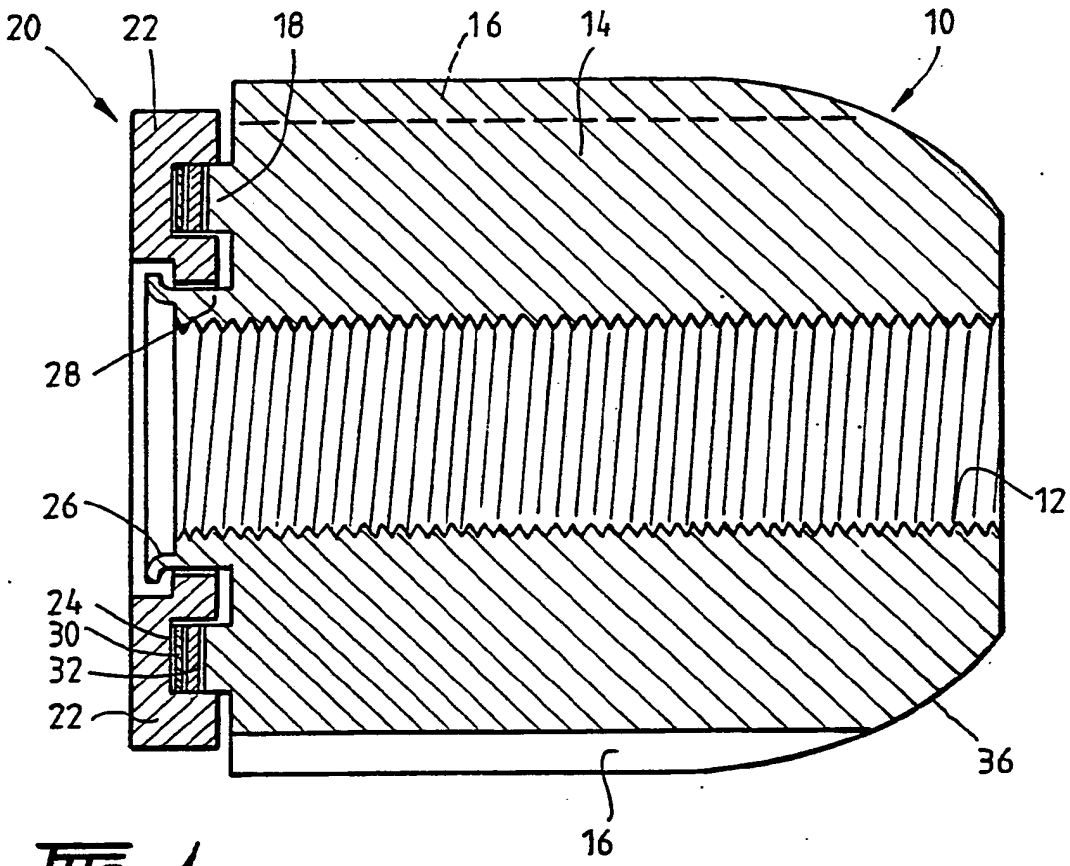

FIG. 1.

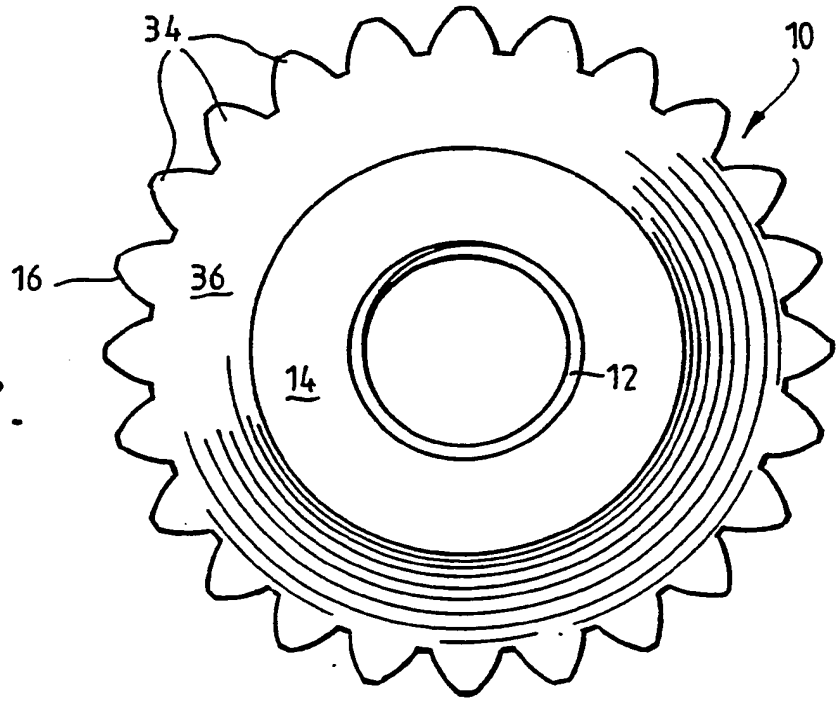

FIG. 2.

SUBSTITUTE SHEET

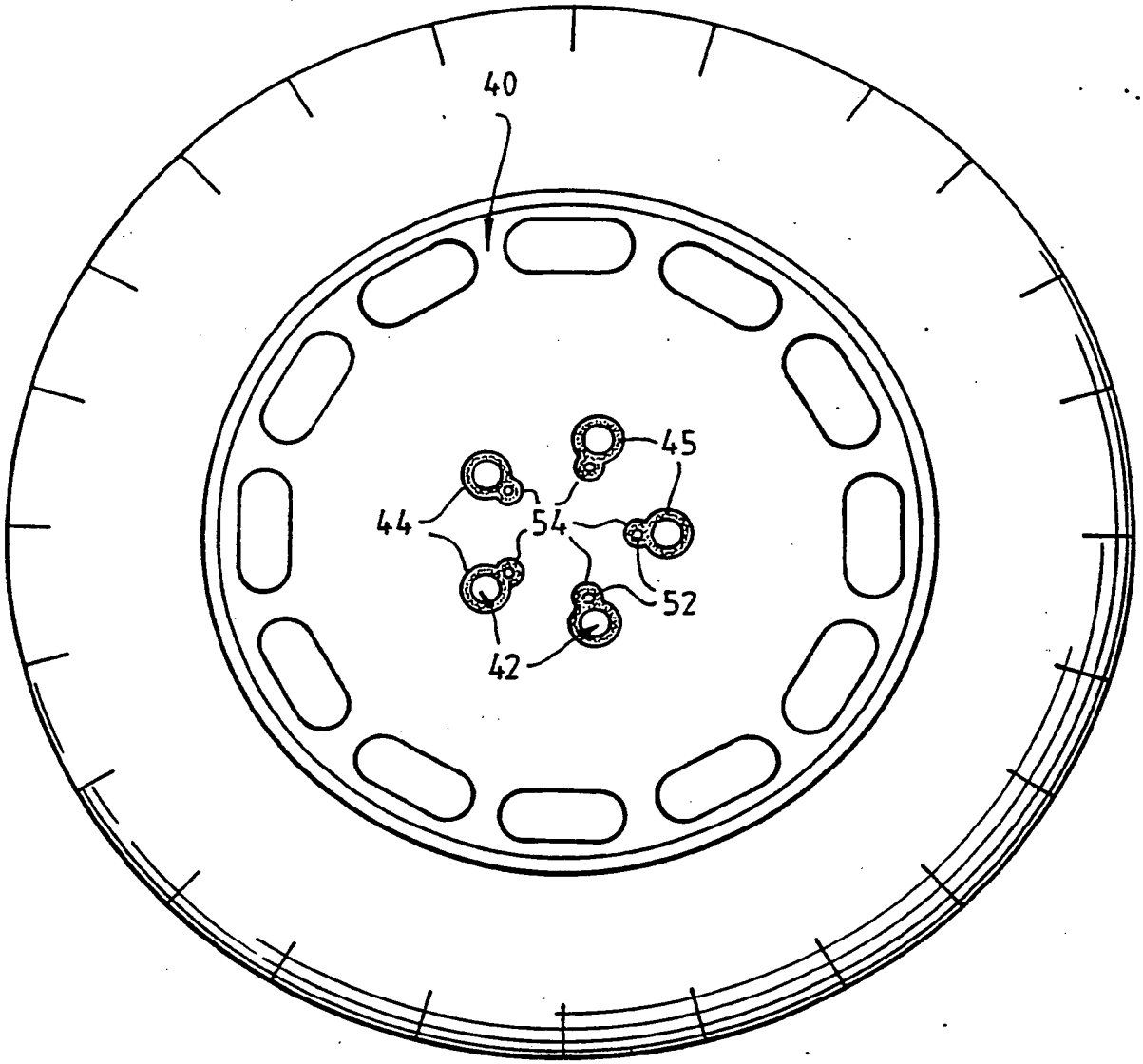

FIG. 3.

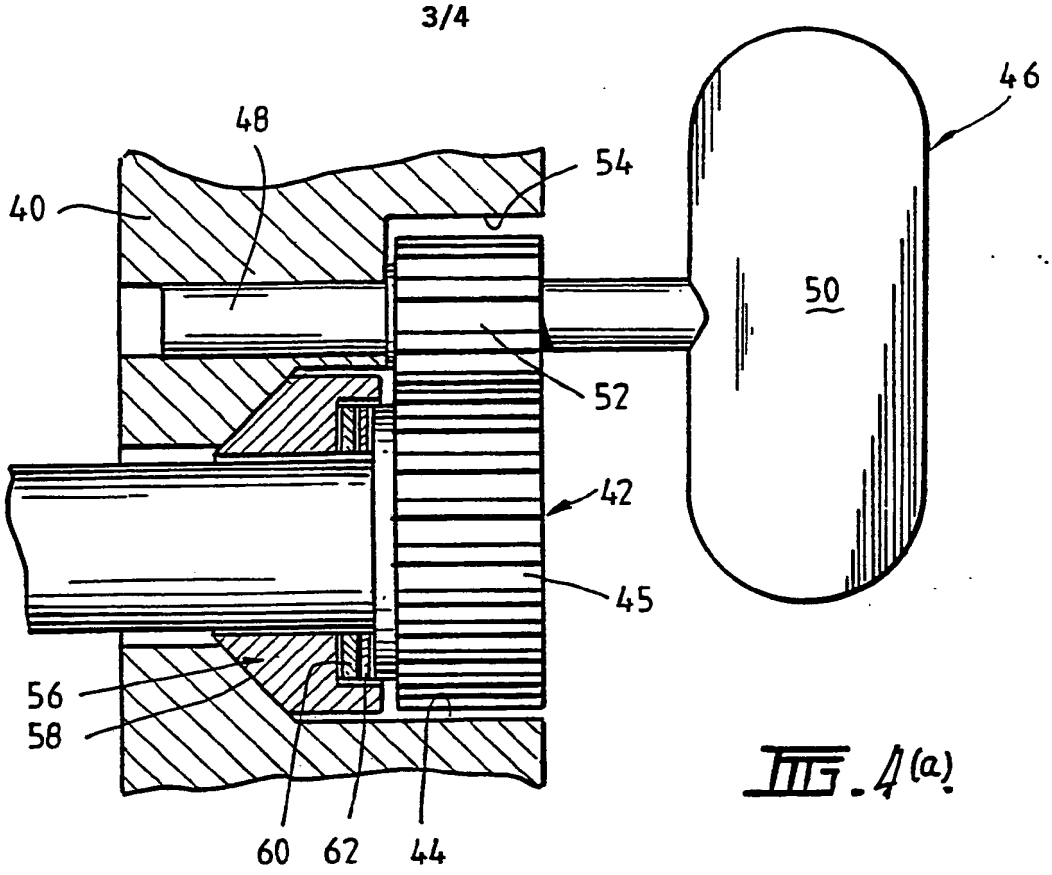

FIG. 4(a)

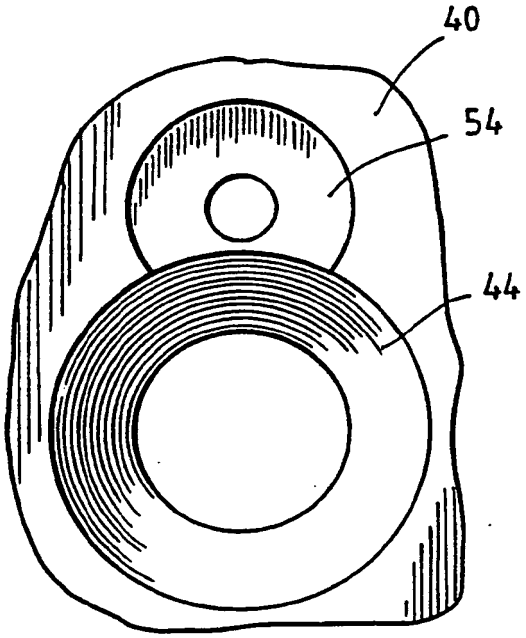

FIG. 4(b)

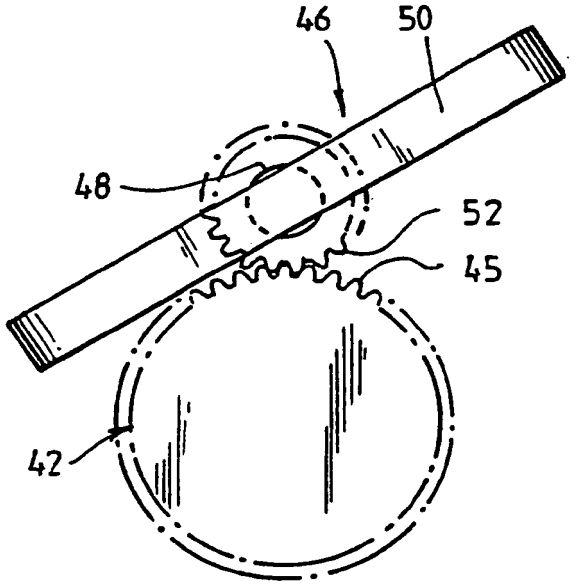

FIG. 4(c)

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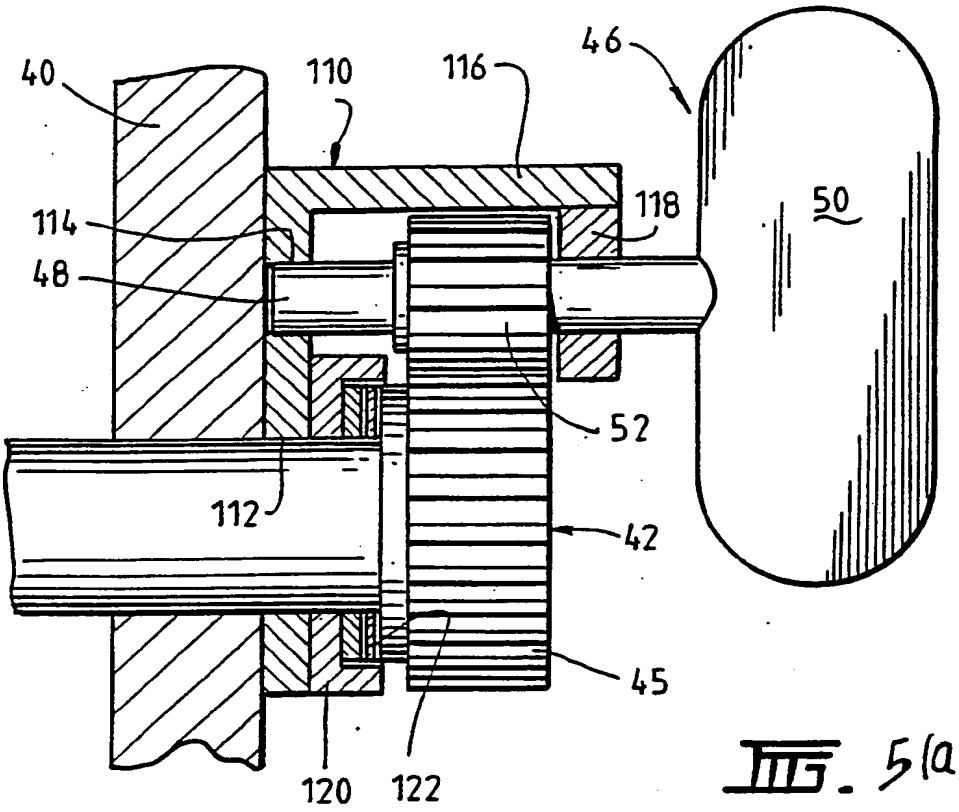

FIG. 5(a)

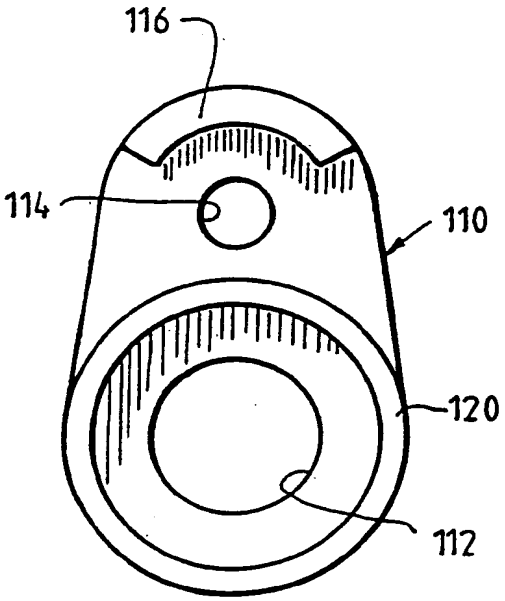

FIG. 5(b)

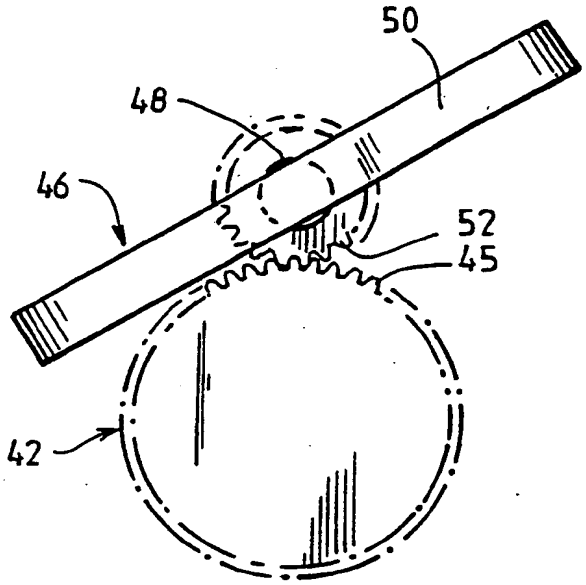

FIG. 5(c)

SUBSTITUTE SHEET

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU92/00393

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl.[5] F16B 23/00, 43/00, B60B 3/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC F16B 23/00, 43/00, B60B 3/16

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU : IPC as above

Electronic data base consulted during the international search (name of data base, and where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
Y	GB,A,2087503 (ROLLS-ROYCE LIMITED) 26 May 1982 (26.05.82) Fig. 1	1-4
Y	US,A,4619559 (NORRIS) 28 October 1986 (28.10.86) Fig.1, col.1 lines 40-53	1-4
Y	GB,A,867013 (HI-SHEAR RIVET TOOL CO) 3 May 1961 (03.05.61) Page 1 lines 60-67, Page 2 lines 35-105	1-4
Y	FR,A,1309208 (MARTIN) 8 October 1962 (08.10.62) Figs. 3 & 4 Whole Document	1-4

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 November 1992 (09.11.92)	12 NOV 1992 (12.11.92)
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No. 06 2853929	Authorized officer G RAMACHANDRAN Telephone No. (06) 2832117

Form PCT/ISA/210 (continuation of first sheet (2)) (July 1992) copshw

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate of the relevant passages	Relevant to Claim No.
X,Y	DE,A,3503883 (KRONPRINZ) 14 August 1986 (14.08.86) Fig.1 Whole document	9
Y	US,A,3871708 (RICHTER) 18 March 1975 (18.03.75) Fig.1 Abstract	9
A	CH,A,314420 (COOKSON) 31 July 1956 (31.07.56)	
A	CH 211159 (DELTA CO) 1 November 1940 (01.11.40)	

Box I **Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)**

This international search report has not established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II **Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

See supplementary sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☒ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically

claims Nos.: 1-10

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☒ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

(continuation) Observations where unity of invention is lacking

This International Searching Authority found multiple inventions in this international application, as follows:

The international application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept. In coming to this conclusion the international searching authority has found:

Claims 1-8 are directed to a threaded fastener having a toothed outer periphery and a head portion.

A friction reducing means is also provided with:

(a) a first part having a first pressure transmitting surface,

(b) a second part in between the first part and the head portion, having second and third pressure transmitting surfaces,

and (c) a solid dry annulus lubricant material acting as a bearing between the first and second parts, when the fastener is tightened or loosened by engaging the toothed outer periphery.

It is considered that the friction reducing means comprises a first special technical feature.

Claims 9 and 10 are directed to a wheel having a plurality of apertures for receiving wheel fasteners having a toothed head portion. A recess is provided on the wheel to rotatably receive a fastening tool for tightening or loosening by engaging the toothed portion of each wheel fastener.

It is considered that the recess and aperture combination comprises a second separate special technical feature.

Claims 11 to 13 are directed to a fastening tool for a fastener having a toothed head portion. The tool is provided with a shank having means for gripping the tool and a complementary toothed portion for tightening or loosening the toothed head fastener. Preferably the tool is in the form of a key having:

(a) the gripping means at one end,

(b) the toothed portion at the other end,

and (c) a key support having an aperture for rotatably receive an end of the shank.

It is considered that the a, b and c combination comprises a third separate special technical feature.

The independent claims 1 and 9 have in common the feature of an outer periphery toothed fastener capable of tightening and loosening by engaging the said outer periphery.

The independent claims 1 and 11 or 9 and 11 have in common the feature of a toothed head fastener capable of being tightened and loosened by engaging the toothed portion.

However the following citations establish that the abovesaid features are known in the art and hence there is a lack of unity a posteriori:

(a) AU, B, 24658/67 (445090) (TEXTRON INDUSTRIES, INC)
23 January 1969 (23.01.69)

(b) AU, B, 58913/65 (400465) (HI-SHEAR CORPORATION)
17 November 1966 (17.11.66)

Since the above-mentioned three groups of claims do not share any of the technical features identified, a "technical relationship" between the inventions as defined in PCT Rule 13.2 does not exist. Accordingly the international application does not relate to one invention or to a single inventive concept.